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Influence of Multidisciplinary Educational Experiences on Engineering and Nutrition Student Perceptions on Collaboration and Soft Skill Development

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INFLUENCE OF MULTIDISCIPLINARY EDUCATIONAL EXPERIENCES ON ENGINEERING AND NUTRITION STUDENT PERCEPTIONS ON COLLABORATION AND SOFT SKILL DEVELOPMENT

by
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ABSTRACT

Caroline Kay Crosby: Influence of Multidisciplinary Educational Experiences on Engineering and Nutrition Student Perceptions on Collaboration and Soft Skill Development
(Under the direction of Dr. Georgianna Mann)

Solutions to most real-world challenges require collaborative efforts by multidisciplinary teams to provide the breadth of perspective and expertise needed to create effective solutions. Interprofessional education is a pedagogical practice used to provide students with opportunities to broaden their professional perspective by encouraging students to work as a part of a diverse team to solve complex problems. This process strengthens discipline-specific skill development, problem-solving skills, and appreciation for other disciplines while providing experiences that are attractive to potential employers. Many students are interested in food science, but no food science courses are offered at the university where this study took place. To prepare students for this career field, an interprofessional product development project was created. This collaboration, between nutrition and chemical engineering, simulated a product development process. Nutrition students started with product design and then interacted with chemical engineering students to design a system capable of producing of 10 million units per year. Students were provided opportunities for meaningful reflection to enhance development of teamwork and communication skills. This multidisciplinary project provided students with an authentic experience of product development, from concept to shelf. The study objective was to analyze educational effectiveness of a seemingly unrelated collaboration between two disciplines and provide feedback for future courses. A mixed methods approach was used including course surveys and analysis of student reflections. Results indicated that students had a self-reported increase in communication skills, growth in leadership roles, improved decision making, and better understanding of their own and other disciplines. Common themes among students and classes included effective communication, successful collaboration, conflict resolution, diverse perspectives, student expectations, and an understanding of group roles. The findings suggest that the implementation of interprofessional education in college curriculum can effectively expose students to new perspectives and provide a unique avenue to promote skill development.

Keywords: Project-based learning, Multidisciplinary, Product development

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INTRODUCTION

Interpersonal Skill Development in Higher Education

The increased complexity of today's problems has amplified the need for so-called "soft" skills in the workplace, such as communication, critical thinking, problem solving, and teamwork (Ritter et al. 2018). Recent reports have suggested that employers feel that their employees often lack soft skills necessary for success (Hurrell 2015). As the job market has become more competitive, hiring managers no longer only consider a candidate's technical skills, but focus on the intangible skills an applicant possesses and employers need. There is an increase in emphasis on what applicants have experienced instead of what was learned in the classroom. With this change in the workplace, there must come an evolution of higher education. Universities must reevaluate their curriculum and how it prepares students for their future careers in today's society. Traditionally, curriculum has focused on technical expertise demonstrated by the knowledge, skills, and capabilities one needs to possess for a specific job, career, or profession. However, recent evidence suggests that curriculum must also incorporate soft skills to ensure student's success after college (Ritter et al. 2018). According to the Job Outlook 2018 survey completed by the National Association of Colleges and Employers, the attributes that employers most value are communication, problem-solving skills, and an ability to work in a team (NACE 2018). While the odds that a student may work within a diverse team during their career is high, Universities rarely give their students the same opportunity to exist within that environment. Incorporating multidisciplinary, team-based projects focused on solving specific tasks into college curriculum provides students the opportunity to learn and thrive in an environment which more closely resembles that of their future careers.

Multidisciplinary Educational Experiences for Soft Skill Development

A multidisciplinary approach to curriculum provides an avenue for students from various disciplines to collaborate and provide solutions to complex problems. Many areas of expertise work together in decision-making and problem-solving by drawing upon their respective knowledge to create a feasible solution (Choi and Pak 2006). Multidisciplinary pedagogy enriches student learning by placing an emphasis on effective communication skills and increased teamwork ability within the context of a real world problem. A high degree of teamwork is critical for this approach and contributes to the overall effectiveness of developing soft skills in students. The primary benefit of multidisciplinary work is the ability to capitalize on a range of perspectives, experience, and knowledge from several different disciplines (Cuevas et al. 2012). A multidisciplinary project provides students with the ability to work in a team, improve collaboration and communication skills, enhance critical thinking, and solve complex problems. Collaboration provides opportunities to learn from one another and go beyond the traditional ways of thinking (Green and Johnson 2015). Interprofessional Education (IPE) is one way to incorporate a multidisciplinary approach in the classroom. It allows one to access knowledge and people that one would not normally have the chance to interact with. The advantages of this approach allow the best solutions to be found for the complicated problems of today's society.

Interprofessional Education/Experiential Learning

Interprofessional Education (IPE) occurs when students from different professions collaborate, learning about, from, and with each other (Green & Johnson, 2015). In order for IPE to be successful, the interaction must involve purposeful integration and collaboration between disciplines. Studies have shown that students that have participated in IPE show more respect and positive attitudes towards each other and work better to solve problems (Green & Johnson, 2015). IPE is a notable way to incorporate soft skill development into curriculum. Studies have shown that participation in IPE provides students an opportunity to develop teamwork skills, problem-solving skills, collaboration skills, and communication skills (Eliot and Kolasa, 2015). IPE is most often used in a healthcare professional education, but it can be applied to many different disciplines. Effective IPE pulls students out of their professional silos and demonstrates how to engage in collaboration (Eliot and Kolasa, 2015). These activities allow for students to understand professional roles, increase teamwork skills, and learn with, from, and about other professions they will be interacting with in the future (Heuer et al, 2010).

Kolb's experiential learning theory is the idea that knowledge is gained through a process and the combination of multiple experiences (Kolb, 1984). This theory is routinely used to provide the framework for developing and evaluating interprofessional education. The learning cycle consists of four parts: concrete experience, observation and reflection, abstract conceptualization, and active experimentation. To effectively learn, the learner must actually engage in activity, review and reflect on the experience, analyze and gain an understanding from the experience, and

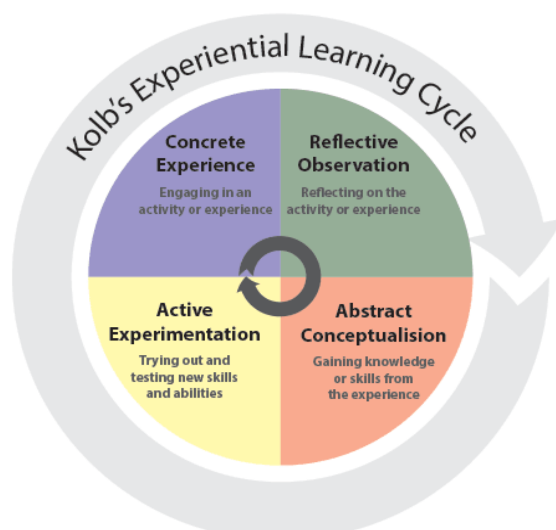

Fig. 1 – Kolb's Experiential Learning Cycle

finally, apply what they have learned (Poore, Cullen, and Schaar 2014). A learner must successfully complete each step of Kolb's learning cycle to fully gain knowledge and in-depth understanding of the subject. Instructors can follow this model to strengthen students' learning in the classroom and accelerate the adaptation of soft skills. Using Kolb's experiential learning theory to develop the IPE allows for effective strategies for design, development, and future IPE implementation.

Roles of Engineers and Nutrition Students

Currently, most undergraduate curriculums focus on the development of knowledge, skills, and abilities within a student's respective discipline. Many students gain in-depth knowledge of their major and how it relates to their respective workplaces. Engineering students often learn various ways to approach problems according to their area of expertise using science and mathematics to solve them (Mills and Treagust 2003). While engineering students are learning complex problem-solving skills, they still stay within a narrow disciplinary focus, only branching out to work with other experts within STEM fields. Many engineering students have a discipline-specific skill set, but in the professional world, problems often require a wide variety of skills and expertise. To solve real-life problems, it is essential for engineers to have the ability to communicate effectively, work in diverse teams, and learn to embrace other ideas. Lasting success in the workforce does not only come from information learned in the classroom, but rather the skills developed along the way which further enables future learning (Rateau, Kaufman, and Cletzer 2015). In one study, researchers investigated how prepared recent chemical engineering graduates felt for the workplace. Students expressed that they observed strengths in their technical background, problem solving skills, formal communication skills, and overall learning abilities, but felt their education was lacking in teamwork, leadership, and management skills. There was a clear distinction between the technical skills that the engineering students possessed and the soft skills that the students lacked (Martin et al. 2007).

While the study of engineering is the link between science and society, nutrition is the link between science and health. Similar to engineering, the nutrition major is often one-dimensional as students are taught by professors of the same discipline, with students of the same discipline (Smith and Christie 2004). Students are only responsible for in-depth knowledge of nutrition and how to implement their knowledge into their own profession. Various research has shown that nutrition and dietetics majors are not prepared for higher critical thinking and problem solving by their undergraduate course work once they reach clinical practice (Lackey and Campa 2008). Critical thinking is an essential soft skill that nutrition graduates going into the dietetics profession need in order to accurately diagnose their client, interpret scientific information to their patient, participate in research and scientific inquiry, and partake in evidence-based practice. In clinical practice, dietitians often work in health care teams with other professionals in regard to a patient, but this knowledge is not taught in the undergraduate curriculum. While many nutrition programs do participate in interprofessional education to simulate clinical practice, it is often in limited ways (Eliot and Kolasa 2015). Nutrition students cannot rely on only the knowledge of their own profession to be successful in the workforce. It is crucial that students develop the soft skills needed to be successful in multidisciplinary projects and interprofessional interactions whether it be in a healthcare setting or food science and technology.

Food Science

With the complexity of today's food supply and global issues, the subject of food science and technology is needed more than ever. Engineering and nutrition are two of the crucial disciplines within food science that have to work together to solve these problems. Food science is a multidisciplinary field that draws on various areas of expertise such as biology, chemical engineering, nutrition, and microbiology to solve the complex food problems facing the world today. Scientists are tasked with understanding the physical, microbiological, and chemical makeup of food to develop safe, new food products and innovative packaging for the world ("Learn About Food Science" 2018). The work of food scientists has extended the shelf life of many products, improved product quality, decreased food prices, and created innovative foods designed for convenience and fun. It takes multiple disciplines to create safe, nutritious food products and develop a process to manufacture, package, market, and sell these it.

The subject of food science can be broken down into four core sciences: food chemistry, food engineering, food microbiology, and sensory science ("Explore Core Sciences" 2018). Food chemistry is responsible for the interactions of the chemical components of food when they are processed, packaged, stored and digested. Food engineering tackles the issues of food processing and large-scale food production. Food microbiology is essential to food safety by understanding spoilage, fermentation, and pathogenic organisms. Sensory and consumer science is tasked with understanding consumer behavior and conducting sensory evaluation on food quality ("Core Sciences" 2018). It is necessary for these four sciences to collaborate and communicate with each other to develop safe, nutritious food to stock supermarket shelves.

The Institute of Food Science and Technology (IFT) breaks down the science into further divisions: nutrition, food safety, product development, public policy, packaging and sustainability. The four core sciences are responsible to work together and create new innovations, breakthroughs, or products in these categories. The nutrition division of IFT researches the science behind developing new food products for weight management and disease prevention. Food scientists may innovate and reformulate foods to fit to the standards of the Dietary Guidelines for Americans (2015) by reducing sodium or sugar in foods. These scientists are also responsible for creating foods for special diets such as celiac's disease or allergen-free foods. In the food processing and packaging division, food scientists are constantly trying to improve the quality, efficiency, and sustainability of the processing and packing of food. Food scientists use scientific and engineering principles to improve and develop new techniques to make food healthier and safer. Food scientists play a critical role in assuring the safety of food by minimizing favorable conditions for pathogenic bacteria to grow and tracking outbreaks. Food scientists must also be knowledgeable about public policy that dictates how the food supply is processed, labeled, and marketed. The decision making of every other division of food science are all linked with public policy ("Science & Policy" 2018). By nature, the food science field is multidisciplinary.

Project Objectives and Expected Outcomes

It is imperative that students leave the comfort of their own field and learn to work in collaboration with other disciplines to strengthen their learning experience and tackle complex problems. To achieve this, a multidisciplinary product development project was proposed between the nutrition and chemical engineering students at The University of Mississippi. This study evaluated the student experience of a multidisciplinary project aimed at enhancing student's soft skills while forcing them to work outside of their own discipline in a team. Through this project, students experienced a comprehensive approach to real world problems. Working with other majors exposed students to diverse perspectives while effectively broadening their horizons. The primary objective of the project was to provide an approach for students to have the opportunity for collaboration while creating meaningful learning experiences focused on the enhancement of student soft skills.

METHODS

Course Structures

Students that participated in this study were enrolled in Experimental Foods (NHM 415) and Plant Design II (ChE 452) at The University of Mississippi. NHM 415 is a required class for nutrition majors that is scheduled for both the fall and spring semesters. ChE 452 is the second required design course for chemical engineering majors and is only offered in the spring. Students in NHM 415 were tasked with developing a food product as a semester-long project. NHM 415 students were given weekly lab assignments to work towards completing this product. Students also had set days for sensory analysis by outside participants to provide formative feedback. Once a food product was chosen, chemical engineering and nutrition students were placed into paired groups consisting of 4-6 students each. As part of the food development project, nutrition students focused on the nutritional value and sensory quality of the food product, while chemical engineering students focused on cost effectiveness and process flow for scale-up. Nutrition students met with chemical engineering students twice during the semester to gain insight on how to cut costs and scale up the production. Groups were required to find time outside of class to meet and discuss the project.

Project Description

For the food development project, groups were required to make a food product centered around a Disney franchise that would be eligible to compete in the IFT Disney Product Development competition (Kuhn 2017). The food product must be either a snack, side dish, or mini meal and meet specific nutrition standards, approved food groups, and ingredients. The food product must be appealing to children, nutritious, and competitive to be sold on supermarket shelves. Mimicking a food scientist's role, students were guided through the process of product design, evaluation, and marketing throughout the course.

Nutrition students enrolled in Experimental Foods (NHM 415) developed a product idea, created the product formulation (recipe), and analyzed cost. Chemical engineering students enrolled in Plant Design II (CHE 452) then worked with the nutrition students to streamline the scale-up process to 10,000,000 units annually and minimize the potential cost of production. Students considered product unit size, the nutritional claims for the product, formulations, and cost of ingredients, and supplies needed for product development. During the course, nutrition students were required to experiment with producing the product, evaluate what succeeded and what failed, and determine changes that needed to be made. During the first consultation with the engineers, nutrition students presented the food product idea and process flow diagram. Groups collaborated on ideas and were asked to be open to changes in formulation to improve costs or efficiency of production. During the second consultation, chemical engineering students presented a complete process flow diagram to produce products at scale as well as making recommendations for formulation changes based on bottlenecks identified during scale-up.

Chemical engineering students were graded based on how well the product process was described, methodology for describing scale-up and the identification of process bottlenecks, plans for implementing solutions to production issues, and appropriateness of estimated costs for full-scale production. Organization, quality of information, and the professionalism of the team were also assessed. Nutrition students were graded on lab activities where they worked on the planning of the product, product experimentation, and product analysis. The final presentation of the product was the final exam.

Participants

Junior and senior-level students enrolled in NHM 415 and CHE 452 participated in the product development project in spring 2018. Pre- and post-surveys were completed at the beginning and end of the semester and two reflective journals based on face-to-face meetings were assigned. Of the 57 students enrolled in both classes, 47 students completed both the pre- and post-surveys and 100 total reflective journals were completed. The study was announced at the beginning of the semester explaining the purpose of the research before any surveys or essays were completed. This study was approved by The University of Mississippi Institutional Review Board (18x-153).

Pre- and post-survey, reflective journals

A mixed methods approach was used for this study: quantitative (pre- and post-survey) and qualitative (reflective journals) techniques were employed to evaluate the effectiveness of the collaborative project. Pre- and post-surveys are essential to gather quantitative data on individual perspectives from a large class setting (Jones, Baxter, and Khanduja 2013). Surveys were conducted to determine differences in students' perceptions of team projects before and after the product development project. Reflective journals are effective tools to understand how the learning occurred and provide an opportunity for specific responses from students to gain more detailed data that is not possible through surveys (Sharma et al. 2017). Results from reflective journals and surveys were analyzed as formative feedback for future courses.

The pre- and post- survey were completed by students enrolled in both courses. Surveys were adapted from the Interprofessional Socialization and Valuing scale (ISVS-21) (King et al. 2010). These questions were used to gather the students' perceptions about the course, group work, and multidisciplinary projects before and after completing the course. The survey was administered online through Qualtrics to all students for credit. The survey consisted of three sections: the first section was six questions of demographics. The second section was a total of 22 questions about students' perception of teamwork and multidisciplinary projects ranked on a seven-point scale (1 = not at all, 7 = to a very great extent). In the pre-survey, the third section was six questions related to students' preferences within education and collaboration on a five-point Likert-type scale (1=strongly disagree, 5=strongly agree). In the post-survey, the third section also included an extra five questions relating to students' opinions on the product development project on the same Likert-type scale.

Throughout the semester, students were required to complete two reflective journals. Prompts were developed by instructors of NHM 415 and ChE 452 for each class. The first journal was completed by the students after the first consultation between the nutrition and chemical engineering groups. Students were asked to summarize the report given and respond to questions about the interaction between the different majors. The second reflective journal was to be completed after the second consultation between groups. Students were asked to summarize the discussed report, interaction between the different majors, and the perspectives of the other discipline. Integrating these two different approaches improves the quality of data and increases the validity of the results (Sharma et al. 2017). The prompts for reflective journals are presented in Tables 1 and 2. These evaluation methods allow for a deeper understanding of what was learned and areas of potential improvement (Misyak et al. 2016). Using this mixed method approach and having data that complements the other, increases the possibility that conclusions were able to be drawn from this study.

Table 1: First set of reflective journal prompts assigned to students in NHM 415 and ChE 452 to evaluate an IPE product development project.

	Reflective Journal Prompts #1
NHM 415	1. Briefly summarize the discussed report in your own words. Your summary should not be identical to any of your group members. 2. Have you encountered any conflict between your group and your clients? If so, describe. How was it resolved? 3. Were you and your group able to communicate to the chemical engineering students effectively? 4. What surprised you about the report feedback you received? 5. How receptive were the chemical engineering students to your report? 6. Do you feel you met the needs of your consults? Why or why not? 7. What information or training may have been beneficial to enhance your group's ability to perform this project? 8. Were you and your group able to communicate to chemical engineering students?
ChE 452	1. Briefly summarize the discussed report in your own words. Your summary should not be identical to any of your group members. 2. Were you and your group able to communicate to the food scientist students effectively? 3. What surprised you about the information you received? 4. What have you learned about food science? 5. How does the perspective of the food scientist students differ from your own? 6. What challenges were present based on initial evaluation of their product?

Table 2: Second set of reflective journal prompts assigned to students in NHM 415 and ChE 452 to evaluate an IPE product development project.

	Reflective Journal Prompts #2
NHM 415	1. Briefly summarize the discussed report in your own words in four sentences. Your summary should not be identical to any of your lab members. 2. Have you encountered any conflict between your group and your chemical engineer consults? If so, describe. How was it resolved? 3. Were you and your group able to communicate to chemical engineering students? 4. What surprised you about the feedback you received? 5. What have you learned about chemical engineering? 6. How does the perspective of the chemical engineering students differ from your own? 7. How can their feedback help improve your product?
ChE 452	1. Briefly summarize the discussed report in your own words. Your summary should Not be identical to any of your group members. 2. Have you encountered any conflict between your group and your clients? If so, describe. How was it resolved? 3. Were you and your group able to communicate to the food scientist students effectively? 4. What surprised you about the report feedback you received? 5. Was the information provided valuable in the preparation of your report? What details were the most surprising? 6. How receptive were the client group to your report and proposed changes to their product? 7. Do you feel you met the expectations of client group? Why or why not? 8. What information or training may have been beneficial to enhance your group's ability to perform this project?

Data analytics

The data from the pre- and post-survey was analyzed using paired t-tests to examine the variances in perceptions of multidisciplinary projects before and after the course. An ANOVA was used to determine specific differences between each group and nutrition and chemical engineering students. The journals were reviewed by two researchers, independently, and themes were identified. A thematic approach was used to analyze the qualitative data collected through the journals. After individual review, researchers discussed and agreed upon theme and sub-theme categories. All qualitative data was imported and coded through NVivo software (QSR NVivo 12, Cambridge, MA, 2018) to identify important themes and visualize relationships between the themes. Coder interrater reliability was acceptable, with 99.54% agreement and a Cohen's kappa of .95 (Landis and Koch, 1977; Krippendorff, 1984).

RESULTS AND DISCUSSION

Surveys

A total of 47 students from NHM 415 (n=25) and ChE 452 (n=22) completed both the pre- and post-survey. Relevant survey questions are presented in Table 3. All pre- and post-survey questions are presented in Appendix A. The pre- and post-surveys indicated improvement in student's knowledge and understanding in certain areas of the course, group work, and multidisciplinary projects. Based on survey results, students found significant growth in their leadership skills throughout the project. Students felt more comfortable being a leader within their group and were able to better initiate discussions to delegate tasks in order to complete the project. This result likely shows that throughout the group work within the project, students became more comfortable in a group setting and their leadership and teamwork skills improved. These qualities mentioned are ones that companies are looking for in job candidates today (NACE 2018). The skills that students developed throughout this project have the potential to enhance their employability and ensure their success in the future workplace.

The survey results also indicated that students felt more comfortable describing their professional role to another team member after the completion of the multidisciplinary project. Knowing one's role in a project is essential for effective communication and collaboration. A significant change in this survey question (p=0.021) demonstrates that since students were interacting with a different discipline than customary, they improved their capacity to understand their own profession. Effective interprofessional education is often noted for its ability to engage students in collaboration and increase their understanding of their own and other professions (Eliot and Kolasa 2015).

Finally, the survey results showed that students became aware of their preconceptions when entering team discussions. When working with multiple disciplines, it is easy to rely on biases about others before actually understanding another discipline. Throughout this multidisciplinary project, there was significant student growth (p=0.027) in their ability to be aware of their biases entering a conversation. While it is noteworthy that students were able to recognize their biases towards the other discipline throughout the project, collaboration would have been more productive if students understood their biases before starting the project. In future classes, it could be advantageous to facilitate a way for students to understand the other discipline before the first meeting. A potential approach includes inviting instructors from chemical engineering and nutrition departments to speak to each class on specific aspects of what their discipline is and what it accomplishes. Additionally, each class could potentially invite a guest speaker such as a food scientist to come in and speak on their job description and how it relates to the two disciplines.

Table 3: Relevant survey questions about students' knowledge of the course, group work, and multidisciplinary projects given to students in NHM 415 and ChE 452 at semester start and end.

Statement Scale 1-7; where 1=not at all and 7 = to a very great extent	Pre	Post
I am aware of my preconceived ideas when entering team discussions*	5.09	5.49
I have an appreciation for using common language across disciplines in a team.	5.06	6.04
I feel comfortable being the leader in a team situation**	5.40	5.68
I feel comfortable in speaking out within the team when others are not keeping the best interest of the project in mind.	5.62	5.66
I feel comfortable in describing my professional role to another team member**	5.35	5.85
I have an appreciation for the value in sharing research evidence across different disciplines in a team.	5.81	5.98
I feel comfortable clarifying misconceptions with other members of a team about the role of someone in my profession.	5.74	5.83
I feel comfortable initiating discussions about sharing responsibility for project completion*	6.00	6.26
I have an appreciation for the benefits in interprofessional team work.	6.00	6.06

*indicates significant differences noted by student's t-test (P<0.05)
**(p<0.025)

Reflective Journals

A total of 100 journals were written by nutrition (n=51) and chemical engineering (n=49) students twice during the semester and were included in the thematic analysis. Through the analysis, four major themes were identified: communication, collaboration, project-specific feedback, and interprofessional education. From these, ten sub-themes were also identified (Table 4). Communication and collaboration were split into two components: effective and ineffective. Project-specific feedback included understanding roles, inadequate information provided, and student expectations. Interprofessional education encompassed diverse perspectives, conflict resolution, and knowledge deficits.

Communication

Effective

The most prominent theme was communication. Students referenced various ways that effective communication took place in their multidisciplinary project meetings. When students came prepared to the meetings, they felt meetings were more efficient. For example, one group came with a list of questions to ask the nutrition students which helped get the meeting started. Comments also suggested that communication was most effective when goals were identified at the start of the meeting. Understanding one another's goals allowed students to ask the right questions and suggest relevant changes to the project.

The majority of the effective communication relied on students having a mutual respect for one other. This includes students having a good rapport, being interested in what others were saying, and having meaningful conversations. A willingness to learn from the other discipline provided a pathway for effective communication. While most of students' enthusiasm to cooperate is intrinsic, motivation can be provided by instructors in future course iterations. Instructors can include feedback from other group members in the final grade of the project offering extra incentive for students to participate. Also, a vital factor for positive working relationships was receptivity and understanding towards suggested changes to the food product. It was crucial for students to explain why they were recommending a change and to explain their proposals in a language that the other discipline could understand.

Table 4: Reflective journal themes, sub-themes, and illustrative quotes for students' perceptions about the project and course itself.

Themes	Sub-themes	Illustrative Quotations
Communication	Effective	"We took the first 5 minutes of the meeting stating our objective for the projects and made sure we reached our goal for the meeting" "My group and I were able to communicate to the chemical engineering students effectively due to their interest in our product design as well as their willingness to learn more about our product."
	Ineffective	"The first meeting went great with good input from both sides, but after that the quality of communication diminished."
Collaboration	Effective	"The clients were incredibly receptive to our ideas and proposed changes. They remained firm in the core integrity of their product while still being flexible to how we felt it should be prepared for such a large-scale process." "All members of both the groups brought a new idea to the table. We all pitched in and came up with an idea that suited both groups." "…it was neat to see the two majors putting our thoughts and ideas into one."
	Ineffective	"Their lack of desire to be a part of the project was apparent after the first meeting…" "They didn't even try out some of the suggestions we came up with in our meeting for their product"
Project-Specific Feedback	Understanding Roles	"We were a bit surprised by all of the questions the students were asking and how much detail they were putting into our product. It made me realize how much truly goes into experimenting with food products and how important chemical engineers are with this process." "I was surprised by the effort they had gone through to test their candy bar before deciding on which ingredients to use" "I have always thought that it was just about chemicals and making things in a lab, but these students made me realize that it is more about production of things then how to transport them and mass produce."
	Inadequate Information Provided	"I think some preparations on what to expect and how to effectively co-operate with students from other departments/fields would help accelerate the project…" "What I do believe would be been beneficial prior to starting the report is more information about the food industry and how to price food industry equipment" "…it may have been helpful if we received the questions they needed to be answered before hand in order to have more time to think about them and give them more in-depth answers."
	Student Expectations	"I was expecting greater collaboration between our two groups and for more creative ideas from the chemical engineer students" "Food science has more troubleshooting and problem solving than I imagined." "Honestly, they superseded our expectations. My lab group partners were all stunned because we did not actually think about the business side or financial costs of our product and warehouse."
Interprofessional Education	Diverse Perspectives	"I am thankful for this experience because it just goes to show what great things can be accomplished when you work together with people with diverse thought processes and ideas." "The great difference in the type of information we wanted, and they initially provided can be attributed to the different outlooks the two majors have." "Having the opportunity to meet with the chemical engineer students has been very eye opening for me personally. I often forget that there are many different majors that can contribute to what we work on as nutrition students."
	Conflict Resolution	"We brought up one issue or question about the project at a time and tried to solve one by one." "However, when we felt the nutritionists were confused by what we were trying to say, we tried as effectively as we could to restate the point in a more understandable language."
	Knowledge Deficit	"Some of the stuff they mentioned was way above our heads, especially when they were discussing procedures out loud among themselves, but overall we communicated very well as a group." We felt slightly unprepared for the meeting with our consults because we did not know they would need specific information like the exact weight and measurements of each cookie after baking."

Ineffective

Ineffective communication was also revealed by students in the reflective journals, but far less often than effective communication. The primary communication problem between groups was slow email interaction and finding a meeting time that worked for everyone. Many groups fixed this problem by creating a group message for more immediate responses and having multiple meetings. Future course guidelines may include a response policy (i.e. "within 24 hours") or suggest alternative communication channels for students to use.

Often misunderstandings regarding the expectations of one another also created difficulties. Group members expressed confusion regarding what meeting topics were. Many groups mentioned that a lack of interest in the project itself led to ineffective communication between members. Some students found pushing for meetings or information from peers to be frustrating. Communication began well for many groups but dwindled throughout the project. A decline in communication could have been correlated to an increase in the demand of schedules toward the end of the school year. Improvement could be seen in future courses by having a shorter timeframe for the project, so deadlines do not conflict with major midterms or finals. Students could also be required to complete more reflective journals as it entices students to critically think about the project and the benefits provided (Poor, Cullen, and Schaar 2014).

Collaboration

Effective

The most effective collaboration took place when students were receptive to ideas and invested in the success of the product. Students needed to be flexible to changes but ensure that core concepts from respective disciplines were maintained such as adhering to specific nutritional guidelines or specific ingredients. Exhibiting interest in the other disciplines opinions and modifications led to the most effective outcomes. Many students mentioned that having the outside opinions and the knowledge of the other group members allowed them to improve their product significantly. As with effective communication, students noticed that having an open mind and being adaptable to changes was a key factor in having a successful collaboration. Students enjoyed seeing how two majors could combine thoughts and ideas into one final product that was the best of both groups. Some students even reported that they wished that they had more collaboration outside the department as this project helped expand their communication skills.

Ineffective

While most students experienced positive collaboration, a few students alluded to ineffective teamwork occurring during the project. Many students related the problems transpiring to students not understanding the guidelines of the project. Comments suggested that some students had conflicting ideas on what was supposed to be done by their group which made it difficult to collaborate across disciplines. There was a lack of motivation by some students to try to cooperate or show any interest to try to collaborate successfully. Unequal contribution by individual group members is a common drawback among group work in universities (Hampton and El-Mallak 2017). Frustrations often arise when students possess a negative attitude or withhold effort from group work (Felps, Mitchell, and Byington 2006). Difficulties resulted when students felt like the other group did not try out their suggestions or give any feedback on their report. Multiple comments mentioned that students did not accept any changes or were not willing to compromise. Requiring students to respond in the reflective journals to prompts about what changes they compromised on or be required to give detailed reasons on why they did not compromise might be beneficial to both groups. More structured meetings between the NHM and ChE students may also be helpful in furthering the collaboration process.

Project-Specific Feedback

Understanding roles

At first, many students were uncertain of the potential contributions that could be provided by their collaborators. A central sub-theme of project-specific feedback was understanding roles. After this project, students felt they better understood the responsibilities of one another's professions. Many students remarked that they had preconceived notions about what a chemical engineer or nutritionist's role was in food science. Students better grasped how multifaceted the role of each other's professions were while working together in close proximity. Chemical engineering students commented that they were surprised by the complexity behind food science and how refined sensory analysis was. Nutrition students often assumed that a chemical engineer only dealt with chemicals and laboratory work. Throughout this project, nutrition students discovered the critical role chemical engineers play in manufacturing and production. Both disciplines were surprised about the extent of the other's professional role.

Inadequate Information Provided

Many students expressed the desire for more project-related information from both instructors and other group members. Chemical engineering students mentioned that more knowledge about the food industry and equipment would have been helpful when preparing their report. Many students conveyed the need for more collaboration between the two disciplines. Suggestions included adding an extra meeting between the groups, spending time with the nutrition students in their sensory lab or joining the two classes together for one class period with the instructors. It may also be beneficial to have an outline of each discipline's specific project and the questions they need answered before the meetings. This would allow students to better understand what information they needed to be prepared with and have answers equipped for possible questions. While combined courses may be difficult due to course scheduling, incorporating the chemical engineering students from the conception of the food product and planning process will allow more collaboration and less confusion on what the students need from each other.

Student Expectations

Students began this project with varying expectations towards working with students in another discipline, but many wrote that their expectations were exceeded. Several students remarked that they were not sure how chemical engineering and nutrition majors could collaborate prior to the project. While at first glance, these two majors have nothing in common, chemical engineering and nutrition both have extensive roles in food science. Students were amazed at how much the two majors could benefit each other. Many students described how the other discipline thought of potential flaws in the product development process that they would have never considered to be important. Besides expectations for the project, students often superseded their expectations from one another. Students were surprised at how receptive the other discipline was to their ideas and how much they could learn from the other major. Nutrition students mentioned that many of them had never thought about how much goes into cost analysis and production, while chemical engineering students wrote that they often dismissed the importance of nutritional content and quality.

Interprofessional Education

Diverse Perspectives

As with any multidisciplinary project, students found that many different and new perspectives were discovered during the progression of this assignment. These findings emerged as a consistent theme throughout the reflective journals. Working with a different discipline can broaden one's perspectives but can also pose many challenges. The nature of multidisciplinary work itself can be seen as a barrier instead of an improvement to learning. Students often find difficulties using a common language between disciplines, understanding the roles of other professions, and appreciating different backgrounds (Sharma et al. 2017). Although these can be seen as obstacles to students, these difficulties are some of the many reasons that the multidisciplinary approach is effective at fostering soft skill development and accumulating new knowledge. In this project, chemical engineering students focused on cost effectiveness and process flow while nutrition students focused on nutritional content and sensory quality. This led to different perspectives on how the groups should move forward with the food products. While this led to conflict between disciplines, many students reported that the conflict was easily resolved through communication and compromise. Students also found that this project allowed them to work with people with a different outlook on the specific food product which helped the groups create a stronger, more feasible product. Suggested changes had to be presented in a format that both disciplines could understand, forcing students to communicate their perspectives while considering their audience.

Conflict Resolution

Conflict is involved in any group project but being able to resolve it is an imperative part of project success. Much of the conflict that arose during this project was attributed to the differences in disciplines. One discipline does not always understand the why or the how behind suggested changes made by another discipline. Often, the nutrition students were more focused on the taste and quality of the food product, such as using branded or fresh ingredients, which increased cost: a primary focus for the chemical engineering students. One group found that the best way to solve this conflict was to address a series of questions from the other discipline one at a time. Compromise was a key factor for solving most conflicts that arose.

Knowledge Deficits

Knowledge deficits emerged as a common theme as chemical engineering and nutrition do not commonly overlap. Often students did not understand all of the information being presented to them. Students had to carefully explain their part of the project so both disciplines could comprehend the assignment. Both disciplines noticed other students lacked knowledge about their area of expertise. A multidisciplinary project opens students up to these experiences where they expand their knowledge about majors they have never interacted with before. Students can be introduced to various roles of different professions, understand their own profession better, and learn how to communicate with other disciplines (Heuer et al. 2010). While students often find these knowledge deficits as obstacles, they will benefit students in the long run.

Other knowledge deficits came from students not understanding their part of the project. Some groups were unsure about the answer to questions and did not have the specific information that the other group needed. Providing the specific questions and information needed before the meeting would help alleviate some of these problems before they arise. Some students noted that they had to do extensive research to understand the food processes and complete the project. A short lesson for engineering student on food processes and equipment could be included in the future to help lessen the confusion experienced by students. Overall, more preparation before the first meeting between groups would have helped both disciplines be better equipped to answer questions and complete the project.

CONCLUSION

Incorporating multidisciplinary educational experiences into college curriculum is perhaps challenging but certainly rewarding for students. Such a project can help create a successful transition from an undergraduate education to competitive employment (Ritter et al. 2018). The goal of this study was to introduce a multidisciplinary project between two seemingly unrelated disciplines and analyze the student perceptions on collaboration and soft skill development throughout the project. Identified themes and survey results indicate that students strengthened their communication, teamwork, and leadership skills while engaging in effective collaboration. These types of soft skills are continually ranked as the most desirable attributes of job applicants. With more employers looking beyond the GPA of college graduates, the development of these skills will allow these students to be more competitive in the workplace (NACE 2018). Students also experienced diverse perspectives, conflict resolution, and the understanding group roles. Learning outcomes and soft skill development were significant which indicates that connecting disciplines across campus is beneficial and can offer more experiences than the existing silos at Universities. Academia can continually improve curriculum to provide students an opportunity to further their knowledge in the classroom and successfully develop the soft skills seen most necessary by employers.

In future course iterations, more collaboration will be included throughout the semester between the chemical engineering and nutrition students. The first meeting between students will be held earlier in the semester, and chemical engineering students will provide more input on sensory analysis, ingredient choice, and the planning process. During a closed sensory analysis, chemical engineering students will be invited to come try the product variations to help further understand the process and the food product. All students will work together instead of separately on developing the final product formulations, product package design, and marketing scheme. Furthermore, there will be an additional meeting between disciplines and a third reflection will be required. With these adjustments, students will engage in collaboration more effectively, and further develop the soft skills required to be competitive in the transition from college to the workplace.

Follow up research is justified with students who participated in this study. A five-question survey was sent out to participants about project feedback, perception of interdisciplinary groups, and employer marketability. This study has the ability for long-term impact on students' soft skill development and future careers.

APPENDIX

Appendix A

Pre- and Post-Survey

Section 1:

1.1 Are you 18 or older?
1.2 First Name
1.3 Last Name
1.4 Email (include @go.olemiss.edu)
1.5 Your age
1.6 Your school year classification
1.7 I am enrolled in…

Section 2:

Answer: (1=not at all, 7 = to a very great extent)

At this point in time, based on my participation in interprofessional (multidisciplinary) education activities…

2.1 I am aware of my preconceived ideas when entering into team discussions
2.2 I have an appreciation for using a common language across disciplines in a team
2.3 I am aware of my own role on a team
2.4 I am able to share and exchange ideas in a team discussion
2.5 I have a perception of myself as someone who engages in multidisciplinary work
2.6 I feel comfortable being the leader in a team situation
2.7 I feel comfortable in speaking out within the team when others are not keeping the best interest of the project in mind
2.8 I feel comfortable describing my professional role to another team member
2.9 I have an appreciation for the value in sharing research evidence across different disciplines in a team
2.10 I am able to negotiate openly with others within a team
2.11 I have an awareness of roles of other members on a team
2.12 I am comfortable engaging in shared decision making with other students
2.13 I feel comfortable in accepting responsibility delegated to me within a team
2.14 I have an understanding of the involvement of outside disciplines in decision making around projects
2.15 I feel comfortable clarifying misconceptions with other members of a team about the role of someone in my profession
2.16 I have an appreciation of the importance of a team approach
2.17 I feel able to act as a fully collaborative member of the team
2.18 I feel comfortable initiating discussions about sharing responsibility for project completion
2.20 I am comfortable in sharing decision making with other professionals on a team
2.21 I have realistic expectations of other professionals on a team
2.22 I have an appreciation for the benefits in interprofessional team work

Section 3: (Pre- and post-survey)
Answer: (1=strongly disagree, 5=strongly agree)

3.1.1 Through my education, I have received meaningful educational experiences working with others outside of my department
3.1.2 Working with others outside of my discipline is an important aspect of a successful career
3.1.3 Creativity is an important aspect of design
3.1.4 Through my education, I have developed an ability to design a system, equipment, or process to meet desired needs within realistic constraints
3.1.5 I see myself as preferring to work on a interprofessional team
3.1.6 Successful team performance requires understanding the roles and responsibilities of each team member.

Section 3: (Post-survey only)
Answer: (1=strongly disagree, 5=strongly agree)

3.2.1 This project improved my understanding of subject matter.
3.2.2 This project required a deeper level of thinking than typical assignments.
3.2.3 This project improved my ability to communicate effectively with technical and non-technical professionals.
3.2.4 This project required the use of subject matter mastered in previous courses to be successful.
3.2.5 Through this project, I have gained an enhanced awareness of roles other professionals on a team.

LIST OF REFERENCES

Choi, Bernard C. K., and Anita W. P. Pak. 2006. “Multidisciplinarity, Interdisciplinarity and Transdisciplinarity in Health Research, Services, Education and Policy: 1. Definitions, Objectives, and Evidence of Effectiveness.” Clinical & Investigative Medicine 29 (6): 351–64.

“Core Sciences - IFT.Org.” 2018. Accessed March 18, 2019. http://www.ift.org/knowledge-center/core-sciences.aspx.

Cuevas, Haydee M, Cheryl A Bolstad, Robert Oberbreckling, Noelle LaVoie, and Diane Kuhl Mitchell. 2012. “Benefits and Challenges of Multidisciplinary Project Teams: ‘Lessons Learned’ for Researchers and Practitioners,” The ITEA Journal (International Test and Evaluation Association), 33 (1). Retrieved from https://commons.erau.edu/publication/108

Eliot, Kathrin A., Kolasa, Kathryn M. 2015 “The Value in Interprofessional, Collaborative-Ready Nutrition and Dietetics Practitioners.” 2015. Journal of the Academy of Nutrition and Dietetics 115 (10): 1578–88. https://doi.org/10.1016/j.jand.2015.03.025.

Green, Bart N., and Claire D. Johnson. 2015. “Interprofessional Collaboration in Research, Education, and Clinical Practice: Working Together for a Better Future.” The Journal of Chiropractic Education 29 (1): 1–10. https://doi.org/10.7899/JCE-14-36.

Hampton, Debra C., and Peggy El-Mallakh. 2017. “Opinions of Online Nursing Students Related to Working in Groups.” Journal of Nursing Education 56 (10): 611–16. https://doi.org/10.3928/01484834-20170918-06.

Heuer, Albert J., Sheryl L. Geisler, Mary Kamienski, Denise Langevin, and Julie O'Sullivan Maillet. 2010. "Introducing Medical Students to the Interdisciplinary Health Care Team: Piloting a Case-Based Approach." Journal of Allied Health 39 (2).https://www.ingentaconnect.com/content/asahp/jah/2010/00000039/00000002/art00005.

Hurrell, Scott A. 2016. "Rethinking the Soft Skills Deficit Blame Game: Employers, Skills Withdrawal and the Reporting of Soft Skills Gaps." Human Relations 69 (3): 605–28. https://doi.org/10.1177/0018726715591636.

Jones, TL, MAJ Baxter, and V Khanduja. 2013. "A Quick Guide to Survey Research." Annals of The Royal College of Surgeons of England 95 (1): 5–7. https://doi.org/10.1308/003588413X13511609956372.

King, Gillian, Lynn Shaw, Carole A. Orchard, and Stacy Miller. 2010. "The Interprofessional Socialization and Valuing Scale: A Tool for Evaluating the Shift toward Collaborative Care Approaches in Health Care Settings." Work 35 (1): 77–85. https://doi.org/10.3233/WOR-2010-0959.

Kolb, David. n.d. "(PDF) Experiential Learning: Experience as The Source of Learning and Development." ResearchGate. Accessed March 18, 2019. https://www.researchgate.net/publication/235701029_Experiential_Learning_Experience_As_The_Source_Of_Learning_And_Development.

Krippendorff, Klaus. 1984. "An Epistemological Foundation for Communication." Journal of Communication 34 (3): 21–36. https://doi.org/10.1111/j.1460-2466.1984.tb02171.x.

Kuhn, Mary Ellen. 2017. “Finalists to Serve up a Taste of Disney Magic in Las Vegas.” June 19, 2017. https://www.iftevent.org/News/finalists-to-serve-up-a-taste-of-disney-magic-in-las-vegas.

Lackey, Denise, and Henry Campa. 2008. “Improving Critical Thinking Skills for Undergraduate Nutrition Students Through Case Studies.” Poster presented at the Center for the Integration of Research, Teaching and Learning Forum 2008.

Landis, J. R., and G. G. Koch. 1977. “The Measurement of Observer Agreement for Categorical Data.” Biometrics 33 (1): 159–74.

“Learn About Food Science - IFT.Org.” 2018. Accessed March 18, 2019. http://www.ift.org/knowledge-center/learn-about-food-science.aspx.

Martin, Rosanna, Bryan Maytham, Jennifer Case, and Duncan Fraser. 2005. “Engineering Graduates’ Perceptions of How Well They Were Prepared for Work in Industry.” European Journal of Engineering Education 30 (2): 167–80. https://doi.org/10.1080/03043790500087571.

Mills, J., & Treagust, D. 2003. Engineering Education - Is problem-based or project-based learning the answer? Australasian Association for Engineering Education, 17.

NACE. 2018. “Employers Want to See These Attributes On Students’ Resumes.” Accessed January 30, 2019. https://www.naceweb.org/talent-acquisition/candidate-selection/employers-want-to-see-these-attributes-on-students-resumes/.

Poore, Julie, Deborah Cullen, and Gina Schaar. 2014. “Simulation-Based Interprofessional Education Guided by Kolb’s Experiential Learning Theory.”

Clinical Simulation in Nursing 10 (5): e241–47. https://doi.org/10.1016/j.ecns.2014.01.004.

Rateau, Richard J., Eric K. Kaufman, and D. Adam Cletzer. 2015. Are project-based learning the answer? How Well They Were Prepared for Work in Journal of Agricultural Education 56 (3): 52Agricultural Education, and D. Adam Cletze

Ritter, Barbara A., Erika E. Small, John W. Mortimer, and Jessica L. Doll. 2018. “Designing Management Curriculum for Workplace Readiness: Developing Students’ Soft Skills.” Journal of Management Education 42 (1): 80–103. https://doi.org/10.1177/1052562917703679.

“Science & Policy - IFT.Org.” 2018. Accessed March 18, 2019. http://www.ift.org/science-and-policy.aspx.

Sharma, B., B. Steward, S.K. Ong, and F.E. Miguez. 2017. “Evaluation of Teaching Approach and Student Learning in a Multidisciplinary Sustainable Engineering Course.” Journal of Cleaner Production 142 (January): 4032–40. https://doi.org/10.1016/j.jclepro.2016.10.046.

Smith, A. Russell, and Catherine Christie. 2004. “Facilitating Transdisciplinary Teamwork in Dietetics Education: A Case Study Approach.” Journal of the American Dietetic Association 104 (6): 959–62. https://doi.org/10.1016/j.jada.2004.03.023.